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## Transdisciplinarity in land use science – A review of concepts, empirical findings and current practices

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### ABSTRACT

In the search for solutions to complex real-world problems, the benefits of transdisciplinary research (TDR) have been widely heralded. Land use science appears to be a designated field for TDR. However, to date, the additional expenses of TDR are accompanied by a so far not proved added value, and empirical findings are claimed to be scarce and dispersed over several disciplines and case studies.

We reviewed 299 articles obtained from a structured literature search to (1) investigate the current differences between theory and practice, (2) identify empirical findings, and (3) ascertain the contributions of TDR to promoting sustainable land use management.

Our results demonstrate that, in spite of an increasing conceptual consistency in the theoretical discussion of TDR, the implementation of TDR remains a substantial challenge, in part because of the gap between theory and practice. In addition, research on TDR is science and process centred. The benefits of TDR in addressing real-world problems within the field of land use remain unproven.

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## 1. Introduction

Over the past two decades, land use science has gradually developed an integrated socio-ecological systems perspective. While the monitoring and modelling of the ecological impacts of land cover changes prevailed in the past (Verburg, Erb, Merz, & Espindola, 2013), currently, a more integrative understanding that moves beyond the limits of disciplinary knowledge and sectoral viewpoints is being pursued.

Land is a limited resource that must fulfil multifunctional societal needs. Currently, multiple factors are driving radical changes in and present growing challenges for land use. These factors include changes in value (e.g., sustainability), economic and social trends (e.g., globalisation, demographic changes), and technological innovations and political priorities as well as the impacts of climate change and growing energy demands (see Weith, Gaasch, Schulz, & Zscheischler, 2010). Complex interactions and feedbacks among these different drivers emerge for varying land use types as well as in distant regions and at multiple spatial scales (Meyfroidt, Lambin, Erb, & Hertel, 2013). Land use conflicts are assumed to rise in the future. Past interventions to promote sustainable land use have often disregarded unintended trade-offs. To understand the complex interdependencies among and within socio-ecological systems, as well as to provide options for action, there is an increasing demand for new knowledge.

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Hence, research concerning sustainable land use must consider diverse societal needs and values as well as local knowledge and, consequently, involve various scientific disciplines, stakeholders and target groups. Land-use scientists, therefore, find themselves in new roles as moderators, negotiators and knowledge providers. These demands, however, must be addressed with appropriate scientific means, methods, and strategies.

Against the backdrop of finding solutions to complex real-world problems, the benefits of transdisciplinary research (TDR) have been widely heralded ever since the concept emerged. Often-argued benefits include an increase in the decision-making capacity of stakeholders (Walter, Helgenberger, Wiek, & Scholz, 2007) by providing “socially robust” and implementable knowledge (e.g., Scholz & Marks, 2001; Nowotny, Scott, & Gibbons, 2001). TDR invokes the capability to rationalise conflicts (Jahn, 2008; Zierhofer & Burger, 2007), to grasp complexity (Pohl, 2008) and to integrate various perspectives and sources of knowledge (Godemann, 2008; Mobjork, 2010; Wickson, Carew, & Russell, 2006).

In connection with natural resource management and the governance of common goods, transdisciplinarity is discussed as an especially promising approach by a growing community of authors (e.g., Dronkers & de Vries, 1999; Fry, 2001; Pohl, 2008; Zscheischler, Rogga, & Weith, 2014). In this respect, land use science appears to be well suited for TDR. The development of land use science has been closely linked to discussions concerning integrative research concepts such as transdisciplinarity and has been associated with initiatives in the field of landscape ecology since the 1970s (e.g., Naveh & Lieberman, 1984; Naveh, 1991; Young, 1974). Both land use as a field of study and discussions of transdisciplinarity have become of increasing interest during the last two decades and have been boosted by the introduction of the concept of sustainability and growing public concern over environmental problems (e.g., Aspinall, 2006; Funtowicz & Ravetz, 1993; Gibbons et al., 1994; Hirsch Hadorn, Bradley, Pohl, Rist, & Wiesmann, 2006; Tress, Tress, & Fry, 2005).

However, TDR is time consuming and demands a large amount of resources. Effect analyses legitimating these higher levels of effort are scarce. Accordingly, the additional expenses of transdisciplinary research have not yet been justified by a demonstrated improvement in results. This deficit can be linked to the lack of empirical findings (e.g., Lieven & Maasen, 2007; Tress, Tress, & Fry, 2007). Empirical findings from TDR projects are dispersed over several disciplines, application fields and case studies.

This paper seeks to narrow this gap by performing a comprehensive meta-study of the current scientific literature. This review focuses on transdisciplinary research conducted within the realm of land use science. The aims of this article are to (1) investigate the relation between theoretical discussion and research practice, (2) identify empirical findings from studies considering transdisciplinary processes in land use research, and (3) ascertain the extent to which TDR contributes to sustainable land use management.

Over the last decade, a number of review articles have addressed the rising need to gather and concentrate the current material associated with transdisciplinary thought and practice. These reviews, however, have centred on a number of various foci. A few authors have described the changing concept of transdisciplinarity also in contrast to other cross-disciplinary approaches (cf. Hirsch Hadorn et al., 2006; Mobjork, 2010; Tress et al., 2005; Wickson et al., 2006). Klein (2008) evaluated TDR and identified seven generic principles. Brandt et al. (2013) conducted a broad quantitative study of the literature with a focus on TD in sustainability research. However, to date, a structured analysis of current TDR practices, empirical findings and the resulting implications is lacking.

## 2. Materials and methods

The reference material includes 299 peer-reviewed, scientific papers. The papers were identified through a structured literature survey of the “ISI Web of Knowledge” and “Scopus” databases (all years) using filters restricted to land use issues. The literature survey was executed in April 2013. All of the possible combinations of the terms “transdisciplinarity”, “integrative research” and “knowledge integration” were entered in the title search. No other search terms were considered. The references were exported to a database; duplicate entries and material not related to the research field of sustainable land use science were excluded. Finally, we filtered the material again for relevance and scope and concentrated the reference material to 167 peer-reviewed scientific papers.

Any statistical findings presented herein and the results section of this paper are based on this dataset. However, for the discussion and introduction, we included additional literature in order to qualify the discourse.

Our methodological approach is based on a qualitative in-depth analysis of each paper and a synthetic approach for qualitative studies modelled after Noblit and Hare (1988). The literature was examined and categorised by basic literature characteristics, i.e., paper category, geographic distribution, and chronology. Second, we extracted the theoretical contributions and empirical investigations relevant to TDR. Subsequently, we examined the theoretical material to identify primary features of transdisciplinarity. Following an iterative process, we analysed, clustered and discussed the empirical findings in relation to the theoretical discussion.

The results are structured into three sections. First, we present a brief statistical analysis of the sample size based on the quantity, geographical distribution and paper category in order to provide an overview of the current dissemination of TDR. Second, we discuss the understanding and use of transdisciplinarity from a theoretical viewpoint. Third, we present the main empirical findings from transdisciplinary practices and discuss these results in relation to the theoretical contributions to TDR.

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